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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/009,910	12/12/2001	Makoto Iida	81839.0107	7347

26021 7590 11/25/2002

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EXAMINER	
SONG, MATTHEW J	
ART UNIT	PAPER NUMBER
1765	

DATE MAILED: 11/25/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)
	10/009,910	IIDA ET AL.
	Examiner	Art Unit
	Matthew J Song	1765

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____ .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-18 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-18 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☒ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 2,4 .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Claim Objections

1. Claim 3-8, 11, 13 and 15 are objected to because of the following informalities: Claim recites "within a range of from 0.183" in line 5, the grammar is incorrect. The examiner recommends deleting "from" to improve the grammar. Appropriate correction is required, likewise for line 5 in claims 4-8, line 8 of claim 11, line 7 of claim 13, line 10 of claim 15 and line 4 of claim 17.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

3. Claims 1 and 5 are rejected under 35 U.S.C. 103(a) as being unpatentable over Iida et al (US 5,968,264) in view of Fujikawa (US 6,277,501).

Iida et al discloses a method of forming a silicon wafer with an N region formed over the entire surface by pulling a crystal from a silicon melt in a Czochralski method at a pulling rate, V, ranging between 0.55-0.58 mm/min and a G ranging from 42.0-45.0 °C/cm from the center to the edge of the silicon ingot, this reads on applicant's controlling V/G because V and G are controlled, therefore the ratio is inherently controlled (Example 1 and 2). Iida et al also discloses in order to establish the N region over the entire cross section of a crystal, a highly precisely

control must be carried out. Also note that the entire reference has been incorporated into the basis of the rejection.

Iida et al does not disclose the silicon single crystal is pulled while doping with carbon.

In a method of forming a silicon wafer, note entire reference, Fujikawa teaches growing a silicon single crystal while controlling the oxygen concentration in the range of $12x10^{17}$-$18x10^{17}$ atoms/cm^3 and controlling the carbon concentration in the range of $0.3x10^{16}$-$2.5x10^{16}$ atoms/cm^3 (col 9, ln 1-67), where $2.5x10^{16}$ atoms/cm^3 of carbon approximately corresponds to 0.5 ppma (col 5, ln 1-67). Fujikawa also teaches annealing a wafer, containing specified amounts of oxygen and carbon, is annealed at 600-900°C for at least more than 15 minutes to achieve a BMD of over $3x10^8/cm^3$ (col 11, ln 1-67). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Iida et al with Fujikawa to promote precipitation of oxygen, thereby producing an epi-wafer without an expensive EG treatment (col 6, ln 1-67 and col 7, ln 1-67).

Referring to claim 5, the combination of Iida et al and Fujikawa teaches annealing at 600-900°C, overlapping ranges are held to be obvious (MPEP 2144.05).

4. Claims 2, 6, 9-18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Iida et al (5,968,264) in view of Fujikawa (US 6,277,501) as applied to claim 1 above, and further in view of Tamatsuka et al (US 6,162,708).

The combination of Iida et al and Fujikawa teaches all of the limitations of claim 2, as discussed previously in claim 1, except the silicon single crystal is doped with nitrogen.

In a method of forming an epitaxial silicon wafer, note entire reference, Tamatsuka et al teaches a silicon single crystal doped with nitrogen in the range of $1x10^{10}$ to $5x10^{15}$ atoms/cm^3 and an interstitial oxygen concentration in the single crystal ingot is 18 ppma or less (col 2, ln 1-67). Tamatsuka et al also teaches annealing at 900°C (col 8, ln 1-67). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Iida et al and Fujikawa with Tamatsuka et al because a silicon single crystal wafer produced by doping nitrogen during growth of the silicon crystal ingot has a high gettering capability, growth of grown in defects incorporated can be suppressed and density of oxide precipitates can be increased (col 6, ln 1-67).

Referring to claim 6, the combination of Iida, Fujikawa and Tamatsuka et al teaches annealing at 600-900°C. Overlapping ranges are held to be obvious.

Referring to claims 11-18, the combination of Iida, Fujikawa and Tamatsuka teaches pulling a silicon single crystal with only a N-region, this reads on applicant's pulled not generate secondary defects, with a carbon concentration of 0.05 ppma, a nitrogen concentration of $1x10^{10}$-$1x10^{15}$ atoms/cm3 and a oxygen concentration of 18 ppma or less and annealing to obtain BMD of over $3x10^8$/cm^3. Overlapping ranges are held to be obvious.

5. Claims 3 and 7 are rejected under 35 U.S.C. 103(a) as being unpatentable over Iida et al (US 5,968,264) in view of Fujikawa (US 6,277,501) as applied to claim 1 above, and further in view of Hourai et al (US 5,954,873).

The combination of Iida et al and Fujikawa teaches all of the limitations of claim 3, as discussed previously, except controlling V/G within a range of 0.183-0.177 mm^2/ K min.

Hourai et al discloses a V/G ratio of 0.183-0.177 mm^2/K min (Fig 2), where dislocation clusters form through the entire wafer, this reads applicant's N-region, where wafers are formed from a silicon single crystal ingot manufactured by the Czochralski method with careful control of the pulling rate and temperature gradient permit a crystal to be formed that is free of Oxidation induced stacking fault rings and other defects (Abstract). Hourai et al also teaches V and G are important parameters for controlling the diameter of an OSF ring (col 4, ln 1-67). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Iida et al and Fujikawa with Hourai et al because a larger V/G allows the crystal to be pulled faster, thereby increasing production.

6. Claims 4 and 8 are rejected under 35 U.S.C. 103(a) as being unpatentable over Iida et al (US 5,968,264) in view of Fujikawa (US 6,277,501) and Tamatsuka et al (US 6,162,708) as applied to claim 2 above, and further in view of Hourai et al (US 5,954,873).

The combination of Iida et al, Fujikawa and Tamatsuka et al teaches all of the limitations of claim 4, as discussed previously, except controlling V/G within a range of 0.183-0.177 mm^2/ K min.

Hourai et al discloses a V/G ratio of 0.183-0.177 mm^2/K min (Fig 2), where dislocation clusters form through the entire wafer, this reads applicant's N-region, where wafers are formed from a silicon single crystal ingot manufactured by the Czochralski method with careful control of the pulling rate and temperature gradient permit a crystal to be formed that is free of

Oxidation induced stacking fault rings and other defects (Abstract). Hourai et al also teaches V and G are important parameters for controlling the diameter of an OSF ring (col 4, ln 1-67). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Iida et al, Fujikawa and Hourai et al with Hourai et al because a larger V/G allows the crystal to be pulled faster, thereby increasing production.

7. Claims 1,3,5, 7 and 9 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hourai et al (US 5,954,873) in view of Fujikawa (US 6,277,501).

Hourai et al discloses a V/G ratio of 0.183-0.177 mm^2/K min (Fig 2), where dislocation clusters form through the entire wafer, this reads applicant's N-region, where wafers are formed from a silicon single crystal ingot manufactured by the Czochralski method with careful control of the pulling rate and temperature gradient permit a crystal to be formed that is free of Oxidation induced stacking fault rings and other defects (Abstract). Hourai et al also teaches V and G are important parameters for controlling the diameter of an OSF ring (col 4, ln 1-67). Also note the entire reference has been incorporated into the basis of the rejection.

Hourai et al does not disclose the silicon single crystal is pulled while doping with carbon

In a method of forming a silicon wafer, note entire reference, Fujikawa teaches growing a silicon single crystal while controlling the oxygen concentration in the range of $12x10^{17}$-$18x10^{17}$ atoms/cm^3 and controlling the carbon concentration in the range of $0.3x10^{16}$-$2.5x10^{16}$ atoms/cm^3 (col 9, ln 1-67), where $2.5x10^{16}$ atoms/cm^3 of carbon approximately corresponds to 0.5 ppma (col 5, ln 1-67). Fujikawa also teaches annealing a wafer, containing specified amounts of oxygen and carbon, is annealed at 600-900°C for at least more than 15 minutes to achieve a

BMD of over $3x10^8/cm^3$ (col 11, ln 1-67). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Hourai et al with Fujikawa to promote precipitation of oxygen, thereby producing an epi-wafer without an expensive EG treatment (col 6, ln 1-67 and col 7, ln 1-67).

Referring to claim 3, 5 and 7, the combination of Hourai et al and Fujikawa teaches a carbon concentration of 0.5 ppma and a V/G of 0.183-0.177 mm^2/K min and annealing at a temperature of 600-900°C. Overlapping ranges are held to be obvious (MPEP 2144.05).

Referring to claim 9, the combination of Hourai et al and Fujikawa teaches a wafer with dislocation clusters throughout the wafer pulled under a similar V/G condition, as applicant, therefore this reads on applicant's N-region. And a carbon concentration of 0.5 ppma.

8. Claims 2, 4,6 8 and 10-18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hourai et al (US 5,954,873) in view of Fujikawa (US 6,277,501) as applied to claim 1 above, and further in view of Tamatsuka et al (US 6,162,708).

The combination of Hourai et al and Fujikawa teaches all of the limitations of claim 2, as discussed previously in claim 1, except doping with nitrogen.

In a method of forming an epitaxial silicon wafer, note entire reference, Tamatsuka et al teaches a silicon single crystal doped with nitrogen in the range of $1x10^{10}$ to $5x10^{15}$ $atoms/cm^3$ and an interstitial oxygen concentration in the single crystal ingot is 18 ppma or less (col 2, ln 1-67). Tamatsuka et al also teaches annealing at 900°C (col 8, ln 1-67). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Hourai et al and Fujikawa with Tamatsuka et al because a silicon single crystal wafer produced

by doping nitrogen during growth of the silicon crystal ingot has a high gettering capability, growth of grown in defects incorporated can be suppressed and density of oxide precipitates can be increased (col 6, ln 1-67).

Referring to claims 6 and 8, the combination of Hourai, Fujikawa and Tamatsuka teaches annealing at 600-900°C, overlapping ranges are held to be obvious (MPEP 2144.05).

Referring to claim 10, the combination of Hourai, Fujikawa and Tamatsuka teaches a nitrogen content of $1x10^{10}$-$1x10^{15}$ number/cm3, overlapping ranges are obvious.

Referring to claims 11-18, the combination of Hourai, Fujikawa and Tamatsuka teaches pulling a silicon single crystal to form only dislocation clusters, this reads on applicant's pulled not generate secondary defects, with a carbon concentration of 0.05 ppma, a nitrogen concentration of $1x10^{10}$-$1x10^{15}$ atoms/cm3 and a oxygen concentration of 18 ppma or less and annealing to obtain a BMD of over $3x10^8$ /cm^3. Overlapping ranges are held to be obvious.

Conclusion

9. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Iida et al (US 6,077,343) teaches a method of forming a silicon wafer consting of a N-region where neither V-rich nor I-rich region is present in the entire surface of the crystal by a CZ method, note abstract.

Wijaranakula (US 5,961,713) teaches a silicon single crystal grown by a Czochralski process with a oxygen content of 10-50 ppma, a density of microdefects of $1x10^9$ /cm^3 or more and annealing a wafer obtained from the silicon ingot at 600-900°C (col 4-5).

Haddad et al (US 4,992,840) teaches a silicon wafer doped with carbon during growth with a carbon concentration of 2.4 ppm (col 6).

Yoshimasa (Abstract of JP 03-183685) teaches a silicon single crystal having 0.1-50 ppma carbon content.

Yutaka (abstract of JP 11-302099) teaches doping a silicon ingot with carbon promotes oxygen precipitation.

10. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew J Song whose telephone number is 703-305-4953. The examiner can normally be reached on M-F 9:00-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Benjamin L Utech can be reached on 703-308-3868. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9310 for regular communications and 703-872-9311 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0661.

Matthew J Song
Examiner
Art Unit 1765

MJS
November 20, 2002

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